

CLAIMS

1. A process for the production of alcohols comprising:
hydroformylating a feedstock comprising at least one olefin in a hydroformylation reactor to form a hydroformylation product comprising an organic phase;
hydrogenating the hydroformylation product in a series of at least two reactors to produce an alcohol, wherein at least one of the hydrogenation reactors comprises a catalyst that can be poisoned by sulphur, and
passing water into the product of the first hydrogenation reactor before the product is passed into the second hydrogenation reactor, wherein substantially all of the water present is dissolved in the organic phase in the second hydrogenation reactor and wherein the feed to the first hydrogenation reactor has a sulphur content of below 1 ppm by weight and a chlorine content of below 1 ppm by weight.
2. A process according to claim 1 comprising adding water to the hydroformylation reactor and to the second hydrogenation reactor, but wherein no further water is added in the first hydrogenation reactor.
3. The process according to claim 1 wherein the process further comprises (a) demetalling the hydroformylation product and/or (b) washing the hydroformylation product, and wherein water from demetalling or washing passes into the first hydrogenation reactor, and wherein substantially all of the water present in the demetalled and/or washed hydroformylation product passed into the first hydrogenation reactor is dissolved in the organic phase in the first hydrogenation reactor.
4. The process according to claim 1 wherein substantially all of the water present in the hydroformylation product passed into the first hydrogenation reactor is dissolved in the organic phase in the first hydrogenation reactor.

5. The process according to claim 1 wherein the sulphur content of the feed to the first hydrogenation reactor is below 0.1 wt ppm.
6. The process according to claim 1 wherein the chlorine content of the feed to the first hydrogenation reactor is below 0.1 wt ppm.
7. The process according to claim 1 wherein the feedstock to the hydroformylation reactor has a sulphur content below 1 wt ppm.
8. The process according to claim 1 wherein the feedstock to the hydroformylation reactor has a chlorine content below 1 wt ppm.
9. The process according to claim 1 wherein the feedstock comprises one or more C₅ to C₁₄ olefins and the alcohol is an C₆ to C₁₅ alcohol.
10. The process according to claim 1 wherein the hydroformylation reactor is operated at elevated temperatures and pressures using a cobalt catalyst.
11. The process according to claim 10 comprising removing cobalt species from the hydroformylation product prior to hydrogenation in the first hydrogenation reactor.
12. The process according to claim 10 comprising treating the hydroformylation product before hydrogenation so that the cobalt content is below 2 wt ppm.
13. The process according to claim 1 comprising operating the hydroformylation reactor at pressures of from 50 to 350 barg and temperatures of from 165 to 185°C.
14. The process according to claim 1 wherein the hydroformylation reaction is performed in a series of at least two reactors.

15. The process according to claim 1 comprising controlling the gas composition in the hydroformylation reactor(s) by controlling the amount and/or composition of the recycle of unreacted gases from hydroformylation step.
16. The process according to claim 14 comprising recycling hydrogen from one or more the hydrogenation reactors to the second (and/or any subsequent) hydroformylation reactors.
17. The process according to claim 14 comprising a series of at least three hydroformylation reactors, the process comprising recycling a hydrogen-rich gas, the hydrogen rich gas comprising recycle gas from one or more hydroformylation reactors and/or one or more hydrogenation reactors.
18. The process according to claim 1 wherein the hydroformylation catalyst comprises a cobalt catalyst and cobalt catalyst species are removed by passing a base into the hydroformylation reaction product in a decobalter vessel positioned downstream of the final hydroformylation reactor.
19. The process according to claim 1 further comprising aldolising at least a portion of an aldehyde product of the hydroformylation step and hydrogenating at least a portion of the aldolisation product.
20. The process according to claim 19 comprising passing water carried over from the aldolisation reactor into the first hydrogenation reactor, the amount of water carried over being such that all the water present in the first hydrogenation reactor is dissolved in the organic phase to be hydrogenated in the first hydrogenation reactor.
21. The process according to claim 20 comprising adding water to the feed to second hydrogenation reactor, the amount of water added being such that all the water present in the second hydrogenation reactor is dissolved in the organic phase.

22. The process according to claim 19 wherein the feedstock for the hydroformylation reactor comprises one or more C2 to C4 olefins.
23. The process according to claim 22 wherein the hydroformylation catalyst comprises a rhodium catalyst.
24. The process according to claim 22 wherein the hydroformylation catalyst comprises a phosphorus ligand.
25. The process according to claim 24 wherein the phosphorus ligand is triphenylphosphine.
26. The process according to claim 24 wherein the phosphorus ligand is an organic phosphite.
27. The process according to claim 26 wherein the organic phosphite is 6,6'-[[3,3',5,5'-tetrakis(1,1-dimethylethyl)-1,1'-biphenyl]-2,2'-diyl] bis(oxy)] bis-dibenzo [d,f] [1,3,2]-dioxaphosphin.
28. The process according to claim 22 wherein the alcohol comprises a C8 alcohol and wherein the olefin comprises propylene.
29. The process according to claim 22 wherein the alcohol comprises a C9 alcohol and wherein the olefin comprises ethylene.
30. The process according to claim 22 wherein the alcohol comprises a C10 alcohol or a C10 alcohol mixture and the olefin comprises butene or a butene mixture.
31. The process according to claim 1 wherein the hydrogenation catalyst is a copper chrome catalyst.

32. The process according to claim 31 wherein the hydrogenation catalyst contains from 20% to 40% by weight of each of copper and chromium based on the total weight of hydrogenation catalyst including any support.

33. The process according to claim 1 wherein the hydrogenation catalyst is selected from the group consisting of a monometallic catalyst composition on a solid support, a bimetallic catalyst composition on a solid support and a trimetallic catalyst composition on a solid support.

34. The process according to claim 33 wherein the support is selected from the group consisting of alumina, silica-alumina and a carbonaceous support.

35. The process according to claim 34 wherein the catalyst further comprises an acidity modifier.

36. The process according to claim 35 wherein the acidity modifier comprises a member selected from Group IA and IIA of the Periodic Table of the Elements.

37. The process according to claim 36 wherein the acidity modifier comprises a member selected from the group consisting of magnesium, sodium, potassium, compounds containing magnesium, compounds containing sodium and compounds containing potassium.

38. The process according to claim 1 wherein the hydrogenation catalyst comprises a transition metal and is dissolved in an ionic liquid.

39. The process according to claim 38 wherein the transition metal is at least one member selected from the group consisting of nickel, cobalt, copper, palladium, chromium, ruthenium, rhodium and mixtures of at least two thereof.

40. The process according to claim 38 wherein the ionic liquid comprises in combination a first component selected from the group consisting of [BF₄]-,

halide anions, [PF₆]⁻, [CF₃COO]⁻, and [SbF₆]⁻, and a second component selected from the group consisting of [emim]⁺, [bmim]⁺, and any other disubstituted immedazolium, the substituents being selected from the group consisting of C1-C4 alkyl, [NBuPy]⁺ and other suitable alkylammonium cations.

41. The process according to claim 1 wherein the product from the first hydrogenation reactor passes in a line to the second hydrogenation reactor and water is injected into the line and the mixture passes to a mixer whereby the water and the product are mixed so that the water is entrained with the product, and the mixture is then passed to the second hydrogenation reactor where it passes through a catalyst bed at a temperature of 170 to 190°C at a hydrogen pressure of 40 to 200 barg.

42. The process according to claim 41 wherein from 1 to 2 wt % of water based on the weight of organic material is injected.

43. A mixture of olefins comprising C5 to C13 olefins comprising at most 90 mol % of normal olefins, the olefin mixture containing below 1 ppm sulphur by weight, and below 1 ppm chlorine by weight.

44. The mixture according to claim 43 comprising at least 3 isomers with different skeletal structures.

45. The olefin mixture according to claim 44 wherein more than 50 wt % of the mixture comprises C8 olefins.

46. A hydrogenation feed stream comprising C6-C15 aldehydes, the hydrogenation feed stream containing no more 1 ppm sulphur and no more than 1 ppm chlorine.

47. The hydrogenation feed stream according to claim 46 comprising an aldehyde containing nine carbon atoms.